

87. The solubility product of  $\text{BaCl}_2$  is  $3.2 \times 10^{-9}$ . What will be its solubility in  $\text{mol L}^{-1}$ ?

- (a)  $4 \times 10^{-3}$  (b)  $3.2 \times 10^{-9}$   
(c)  $1 \times 10^{-3}$  (d)  $1 \times 10^{-9}$

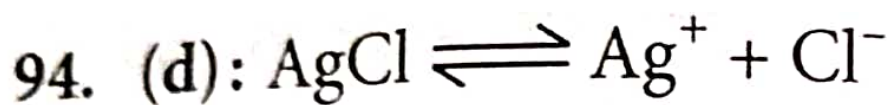
88. Solubility of  $\text{CaF}_2$  is  $0.5 \times 10^{-4} \text{ mol L}^{-1}$ . The value of  $K_{sp}$  for the salt is

- (a)  $5 \times 10^{-12}$  (b)  $2.5 \times 10^{-16}$   
(c)  $1 \times 10^{-13}$  (d)  $5 \times 10^{-13}$

89. Match the column I with column II and mark the appropriate choice.

Column I		Column II	
(A)	$\text{Fe}(\text{OH})_3$	(i)	$K_{sp} = s^2$
(B)	$\text{Ag}_2\text{CrO}_4$	(ii)	$K_{sp} = 27s^4$
(C)	$\text{CH}_3\text{COOAg}$	(iii)	$K_{sp} = 108s^5$
(D)	$\text{Ca}_3(\text{PO}_4)_2$	(iv)	$K_{sp} = 4s^3$

- (a) (A)  $\rightarrow$  (iii), (B)  $\rightarrow$  (ii), (C)  $\rightarrow$  (iv), (D)  $\rightarrow$  (i)  
(b) (A)  $\rightarrow$  (ii), (B)  $\rightarrow$  (iv), (C)  $\rightarrow$  (i), (D)  $\rightarrow$  (iii)  
(c) (A)  $\rightarrow$  (i), (B)  $\rightarrow$  (iii), (C)  $\rightarrow$  (ii), (D)  $\rightarrow$  (iv)  
(d) (A)  $\rightarrow$  (iv), (B)  $\rightarrow$  (i), (C)  $\rightarrow$  (iii), (D)  $\rightarrow$  (ii)



$$s^2 = 1.5625 \times 10^{-10}$$

$$s = 1.25 \times 10^{-5} \text{ mol L}^{-1}$$

$$\text{Solubility in g L}^{-1} = \text{Molar mass} \times s$$

$$= 143.5 \times 1.25 \times 10^{-5} = 1.79 \times 10^{-3} \text{ g L}^{-1}$$



(c)  $4 \times 10^{-10} \text{ M}$

94. The solubility product of AgCl is  $1.5625 \times 10^{-10}$  at  $25^\circ\text{C}$ .  
Its solubility in grams per litre will be

(a) 143.5

(b) 108

(c)  $1.57 \times 10^{-8}$

(d)  $1.79 \times 10^{-3}$

□ **Example 92.**

The solubility of silver chloride ( $\text{AgCl}$ ) in water at  $25^\circ\text{C}$  is  $1.06 \times 10^{-5} \text{ mol L}^{-1}$ . Calculate the solubility product of  $\text{AgCl}$  at this temperature.

**Solution:** The solubility equilibrium of  $\text{AgCl}$  is :



One mole of  $\text{AgCl}$  in solution gives 1 mole of  $\text{Ag}^+$  ions and 1 mole of  $\text{Cl}^-$  ions. Since the solubility of  $\text{AgCl}$  is  $1.06 \times 10^{-5} \text{ mol L}^{-1}$ , it will give  $1.06 \times 10^{-5} \text{ mol L}^{-1}$  of  $\text{Ag}^+$  ions and  $1.06 \times 10^{-5} \text{ mol L}^{-1}$  of  $\text{Cl}^-$  ions. Therefore,

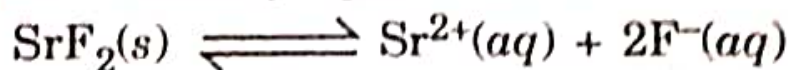
$$\begin{aligned} [\text{Ag}^+] &= 1.06 \times 10^{-5} \text{ mol L}^{-1}, [\text{Cl}^-] \\ &= 1.06 \times 10^{-5} \text{ mol L}^{-1} \end{aligned}$$

Now, 
$$\begin{aligned} K_{sp} &= [\text{Ag}^+][\text{Cl}^-] \\ &= (1.06 \times 10^{-5}) \times (1.06 \times 10^{-5}) \\ &= 1.12 \times 10^{-10} \end{aligned}$$

□ **Example 93.**

The solubility of  $\text{SrF}_2$  in water is  $1.2 \times 10^{-2} \text{ g L}^{-1}$ . Calculate the solubility product of the salt at room temperature (molecular mass of  $\text{SrF}_2 = 125.6$ ).

**Solution:** The solubility equilibrium is :



$$\text{Solubility of SrF}_2 = 1.2 \times 10^{-2} \text{ g L}^{-1}$$

$$\text{Molar solubility of SrF}_2 = \frac{1.2 \times 10^{-2}}{125.6} = 9.55 \times 10^{-5} \text{ mol L}^{-1}$$

According to above equation, one mole of  $\text{SrF}_2$  produces one mole of  $\text{Sr}^{2+}$  ions and two moles of  $\text{F}^-$  ions. Therefore,

$$[\text{Sr}^{2+}] = 9.55 \times 10^{-5} \text{ mol L}^{-1}$$

$$[\text{F}^-] = 2 \times 9.55 \times 10^{-5} = 19.1 \times 10^{-5} \text{ mol L}^{-1}$$

$$\begin{aligned} K_{sp} &= [\text{Sr}^{2+}] [\text{F}^-]^2 \\ &= (9.55 \times 10^{-5}) \times (19.1 \times 10^{-5})^2 \\ &= 3.48 \times 10^{-12} \end{aligned}$$

**Solution:**  $\text{BaCl}_2$  dissociates completely as :

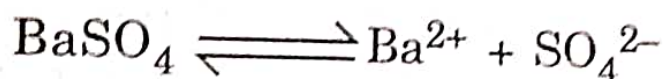


Conc. of  $\text{Ba}^{2+}$  in 0.05 M  $\text{BaCl}_2$  solution is

$$[\text{Ba}^{2+}] = 0.05 \text{ M}$$

Let solubility of  $\text{BaSO}_4$  in 0.05 M  $\text{BaCl}_2$  solution be  $x$  mol  $\text{L}^{-1}$ .

Then



$$[\text{Ba}^{2+}] = x \text{ mol L}^{-1}, [\text{SO}_4^{2-}] = x \text{ mol L}^{-1}$$

$$\text{Total } [\text{Ba}^{2+}] = 0.05 + x \approx 0.05 \text{ M}$$

( $\because x$  is very small)

$$K_{sp} = [\text{Ba}^{2+}] [\text{SO}_4^{2-}]$$

$$= (0.05) \times x$$

or

$$0.05 x = 1.1 \times 10^{-10}$$

$$x = \frac{1.1 \times 10^{-10}}{0.05}$$

$$= 2.2 \times 10^{-9} \text{ mol L}^{-1}.$$



□ **Example 102.** Calculate the solubility of barium sulphate in 0.05 M barium chloride solution.  $K_{sp}$  of  $BaSO_4$  =  $1.1 \times 10^{-10}$ .

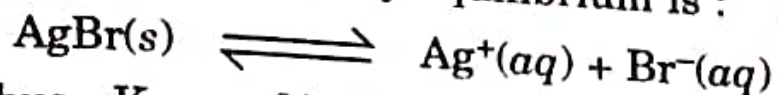
**N.C.E.R.T.**

## SOLVED EXAMPLES

### □ Example 94.

The solubility product of silver bromide is  $3.3 \times 10^{-13}$ . Calculate its solubility.

**Solution:** The solubility equilibrium is :



$$\text{Thus, } K_{sp} = [\text{Ag}^+][\text{Br}^-]$$

Let the solubility of AgBr be  $s \text{ mol L}^{-1}$ , then  $s$  moles of AgBr dissolved will give  $s$  moles of  $\text{Ag}^+$  and  $s$  moles of  $\text{Br}^-$  ions. That is

$$[\text{Ag}^+] = s, [\text{Br}^-] = s$$

$$\therefore K_{sp} = [\text{Ag}^+][\text{Br}^-] = s \times s$$

$$\text{or } 3.3 \times 10^{-13} = s^2$$

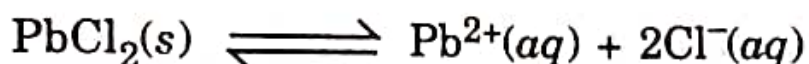
$$\text{or } s = \sqrt{3.3 \times 10^{-13}} = \sqrt{33 \times 10^{-14}}$$

$$= \sqrt{33} \times 10^{-7} = 5.74 \times 10^{-7} \text{ mol L}^{-1}$$

### □ Example 95.

Calculate the solubility of  $\text{PbCl}_2$  if its solubility product is  $1.0 \times 10^{-6}$  at 298 K.

**Solution:** The solubility equilibrium is :



Suppose the solubility of  $\text{PbCl}_2$  is  $s$  moles per litre. Then the concentrations of various species at equilibrium are :

$$[\text{Pb}^{2+}] = s, [\text{Cl}^-] = 2s$$

$$\text{Now, } K_{sp} = [\text{Pb}^{2+}][\text{Cl}^-]^2$$

$$1.0 \times 10^{-6} = (s) \times (2s)^2$$

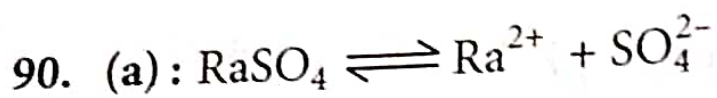
$$1.0 \times 10^{-6} = 4s^3$$

$$\text{or } s^3 = \frac{1.0 \times 10^{-6}}{4}$$

$$\text{or } s = 6.3 \times 10^{-3} \text{ mol L}^{-1}$$

Thus, solubility of  $\text{PbCl}_2 = 6.3 \times 10^{-3} \text{ mol L}^{-1}$

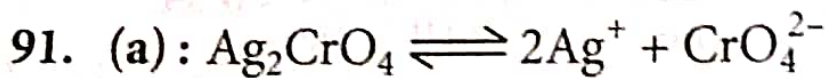




$$K_{sp} = [\text{Ra}^{2+}] [\text{SO}_4^{2-}]$$

Concentration of  $\text{SO}_4^{2-}$  from  $\text{Na}_2\text{SO}_4 = 0.10 \text{ M}$

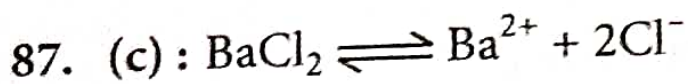
$$\text{Ra}^{2+} = \frac{4 \times 10^{-11}}{0.10} = 4 \times 10^{-10} \text{ M}$$



$$\text{Ag}^+ = 1.5 \times 10^{-4} \text{ M}$$

$$\text{CrO}_4^{2-} = 0.75 \times 10^{-4} \text{ M} \left( \frac{1}{2} \text{ of } \text{Ag}^+ \right)$$

$$K_{sp} = (1.5 \times 10^{-4})^2 \times (0.75 \times 10^{-4}) = 1.687 \times 10^{-12}$$



$$K_{sp} = [\text{Ba}^{2+}][\text{Cl}^-]^2 = x \times (2x)^2 = 4x^3$$

$$4x^3 = 3.2 \times 10^{-9}$$

$$\Rightarrow x = 9.28 \times 10^{-4} = 0.928 \times 10^{-3} \approx 1 \times 10^{-3}$$



Solubility (conc):  $0.5 \times 10^{-4}$   $(2 \times 0.5 \times 10^{-4})^2$

$$K_{sp} = 0.5 \times 10^{-4} \times 1 \times 10^{-8} = 0.5 \times 10^{-12} \text{ or } 5 \times 10^{-13}$$

